A Dynamic Enhancement Background Reduction Algorithm (DEBRA) Applicable to GOES-R ABI

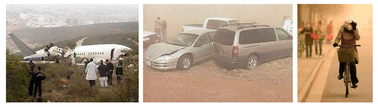
Steven D. Miller
Cooperative Institute for Research in the Atmosphere (CIRA)
Colorado State University, Fort Collins, CO

NOAA Satellite Conference for Direct Readout, GOES/POES, and GOES-R/JPSS Users

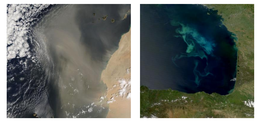
Current and Future Programs and Systems
Poster Session 2: #W87, 10 April 2013

1. Importance of Aeolian Mineral Dust

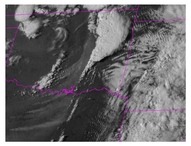
Hazards to transportation and respiratory health...



Ocean nutrification (iron) processes…



Cloud/aerosol interactions…



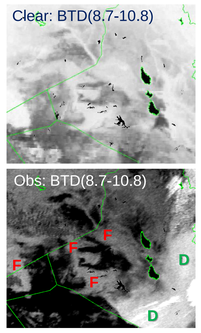
Accelerated snow melt…

2. Satellite-Based Detection, Challenges

Environmental satellites offer the best perspective on global dust

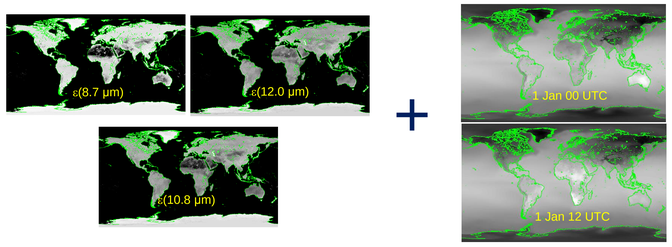
12.0-10.8 μm and 8.7-10.8μm brightness temperature differences (BTDs) provide sensitivity to lofted dust

Some land surface types produce BTDs that are similar to the dust signals (D) → leading to false alarms (F)…



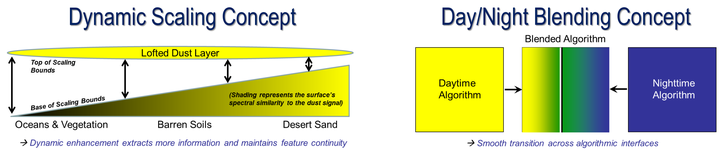
3. DEBRA Concept & Methodology

To mitigate potential surface signal ambiguities, first we estimate the cloud/dust-free (clear-sky) scene:



We use the U.Wisconsin Baseline Fit Emissivity Database[1] (0.05˚ grid, monthly, multi-year mean), coupled with the NASA MERRA[2] surface temperature (0.1 ˚ grid, hourly) to compute clear-sky (12.0-10.8 μm) and (8.7-10.8μm) "background" BTDs.

These BTDs become the low-end of a dynamic scaling.



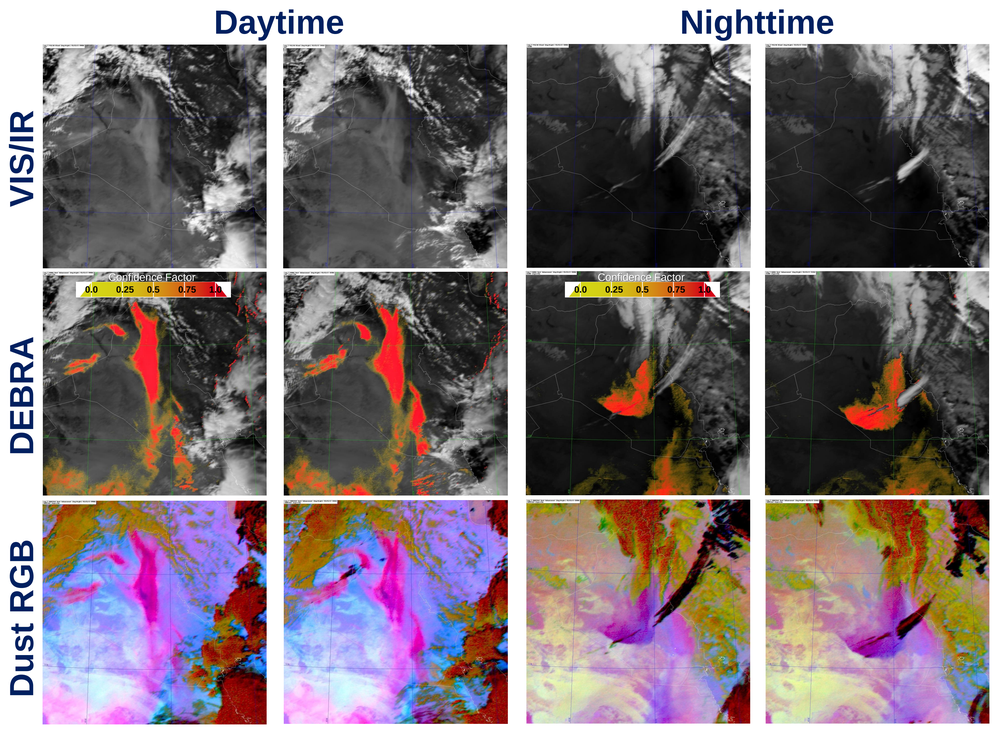
The DEBRA confidence factor is a weighted combination of the BTDs and thermal contrast tests, applied to cloud-free pixels.

4. Examples of DEBRA's Application to Lofted Dust

DEBRA has been applied to Meteosat Second Generation (MSG) Spinning Enhanced Visible and Infrared Imager (SEVIRI) data. A case study over Iraq is shown below to illustrate typical daytime & nighttime algorithm performance.

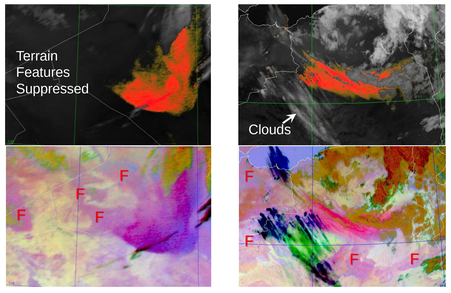
Performance is compared against vis/ir imagery and the EUMETSAT Dust RGB enhancement → for a case study over Iraq on 23 Mar 2013.

DUST (night & day)					
RGB colour plane	channel (difference)	MIN	MAX	GAMMA	Prominent features
R	12.0 - 10.8	-4 K	+2 K	1.0	Dust (over land) Thin Ci Contrails
G	10.8 - 8.7	þ K	+15 K	2.5	
B	10.8	261 K	289 K	1.0	



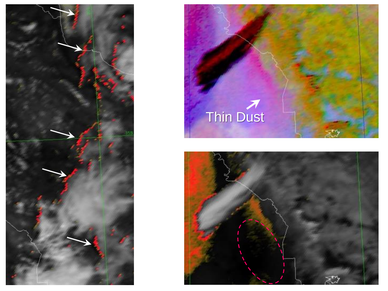
5. Advantages

- Reduces the false-alarm (F) field
- *Quantitative mask*: confidence index [0-1]
- Simplifies imagery interpretation
- Day/Night consistency of enhancement



6. Limitations

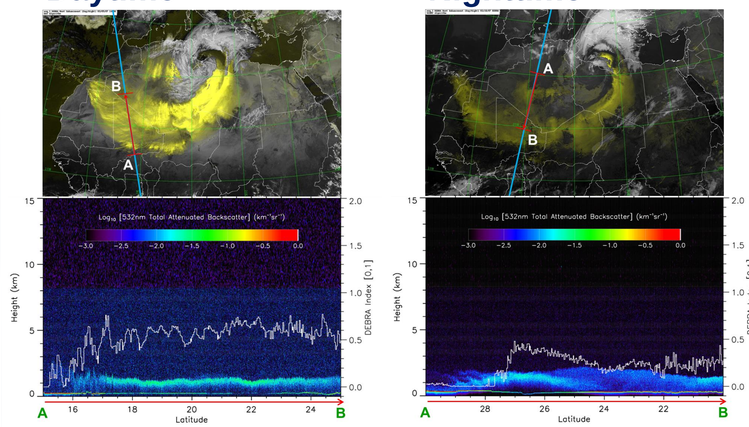
- Sacrifices some sensitivity to weak signals
- Cannot detect dust beneath clouds
- Performance tied to cloud mask quality
- Confidence index *does not* map linearly to aerosol optical depth (useful as a mask only)



7. Comparisons Against CALIPSO

Preliminary comparisons of the DEBRA confidence index were made against CALIPSO (532 nm lidar) observations.

DEBRA values [0-1] were extracted along the nadir (non-scanning) CALIPSO profile for day and night scenes:



Confidence factor is generally larger for optically thick dust, but relationship is also a strong function of the dust height.

A ~linear relationship between AOD [0.0,1.0] and DEBRA [0.0,0.25] was found for the 4 cases examined, but this is not considered a robust statement.

Detection breaks down in regions of thin cirrus, high water vapor content and for low-level, optically thin dust.

8. Future JPSS & GOES-R Applications

Land surface false alarms are mitigated in part by the temporal resolution of geostationary observations (dust features move). Polar-orbiting systems do no enjoy this same luxury.

A version of DEBRA-dust for the Suomi National Polar-orbiting Partnership (S-NPP) Visible/Infrared Imager Radiometer Suite (VIIRS) is currently in development.

When applied to VIIRS and the GOES-R Advanced Baseline Imager (ABI) observations, the algorithm will benefit from additional spectral information:

- Blue light band (better daytime dust detection)
- Shortwave water vapor band (better cirrus filtering)
- Day/Night Band (VIIRS; low-level dust over water @ night)

DEBRA-based applications to other parameters that can experience land-surface false alarms include:

- Volcanic ash plumes
- Nighttime low clouds and fog

1. Seemann, S.W., E. E. Borbas, R. O. Knuteson, G. R. Stephenson, H.-L. Huang, 2008: Development of a Global Infrared Land Surface Emissivity Database for Application to Clear Sky Sounding Retrievals from Multi-spectral Satellite Radiance Measurements.J. Appl. Meteor. Climatol., 47, 108-123.

2. Rienecker, M. M. and 28 Co-authors, 2011: MERRA: NASA's Modern-Era Retrospective Analysis for Research and Applications. J. Climate, 24(14), 3624-3648.

ACKNOWLEDGMENTS: Research sponsored by the Naval Research Laboratory through contract NOO173-10-C-2003, the Oceanographer of the Navy through the Program Executive Office PMW-120 under program element PE-0603207N, and the National Oceanic and Atmospheric Administration Joint Polar Satellite System Cal/Val and Algorithm program. The views, opinions, and findings in this presentation are those of the authors, and should not be construed as an official US Government position, policy, or decision.